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Can global chemistry-climate models reproduce air-quality extremes?

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A novel analysis of surface ozone measurements is shown to identify and characterize extreme air pollution episodes over the USA and EU. Over a decade of observations, major episodes are found and for the most part as coherent, connected synoptic patterns lasting a few days and covering 1000 x 1000 square km. The integrated exposure of human population and agriculture/ecosystems is heavily weighted towards these mega-episodes. The skill of global chemistry-climate models (CTMs) in reproducing these episodes (defined in terms of maximum daily 8-hour average values: MDA8 in ppb or nanomoles per mole) is tested using the UCI high-resolution (100 km) global chemistry-transport model in a hindcast mode to match the individual episodes. Although the UCI CTM has significant biases in surface ozone, it correctly identifies the major synoptic, multi-day episodes. Tests show (i) this skill is robust to different approaches in generating a gridded observational data set and (ii) the correlation coefficient at the 100-km scale ($\sim$0.25) is robust to white noise in the individual surface site measurements up to about 10 ppb. We conclude that even at relatively coarse resolution, global chemistry-climate models can be used to project major synoptic pollution episodes driven by large-scale climate and chemistry changes, although local absolute exposure will remain dominated by local emissions.